A STUDY OF SPOTTED OWL DEMOGRAPHICS IN THE SIERRA NATIONAL FOREST AND SEQUOIA AND KINGS CANYON NATIONAL PARKS

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A STUDY OF SPOTTED OWL DEMOGRAPHICS IN THE SIERRA NATIONAL FOREST AND SEQUOIA AND KINGS CANYON NATIONAL PARKS

by

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INTRODUCTION

This report summarizes key activities and preliminary results of demographic studies of California spotted owls (*Strix occidentalis occidentalis*) in the Sierra National Forest and the Sequoia and Kings Canyon National Parks for 1999. Demographic studies were initiated in March of 1990. Information collected will allow comparisons between spotted owl demographics in a managed National Forest and protected forests of the National Park. In 1994 an additional study area was initiated in Sierra National Forest to provide complete coverage of the Kings River Sustainable Forest Ecosystem Project Area. Results from all study areas are provided in this report. All tables and figures have been updated to reflect the current analysis of data for all years (1990-1999) and those tables and figures supersede all previous annual reports. Data contained herein are preliminary and permission to publish any of the contents of the report is therefore withheld pending specific authorization.

OBJECTIVES

1. Estimate densities of spotted owls and occupancy status of owl territories in the designated study areas.
2. Estimate vital rates (reproduction, mortality) by age class.
3. Assess site fidelity among individual spotted owls.
4. Estimate the number of missing and replaced spotted owls.
5. Quantify the distribution of habitats within the study areas.
6. Characterize diets of spotted owls from regurgitated pellets, and compare diets of breeding and nonbreeding pairs during the breeding period (1 March to 30 September).

STUDY AREAS

Boundaries of study areas were delineated on major topographic features such as ridges, drainages (major rivers), and administrative boundaries (e.g., Sequoia and Kings Canyon National Parks boundaries). The Sierra National Forest study area (SNF) covers 161 mi^2, the New Sierra study area (NS) covers 103 mi^2 and the Sequoia and Kings Canyon National Parks study area (SNP) covers 130 mi^2 (fig. 1). Three vegetation zones are found in all study areas, oak woodland (1,000 to 4,000 feet), mid-elevation coniferous forest (4,000 to 8,000 feet) and high elevation coniferous forest (8,000 to 9,600 feet). A detailed description of these vegetation types and the area they occupy for the SNF and SNP can be found in the 1990 annual report (Verner et al. 1990), and for NS can be found in the 1993-1994 annual report (Steger et al. 1995).

METHODS

We attempted to locate, capture, and color band all spotted owls within the three study areas. Spotted owls were located by night and day calling surveys using vocal imitations of spotted owls to elicit responses (Forsman 1983). Survey methods included point surveys, leap-frog road surveys, and walking cruises. All study areas were subdivided into sites that could usually be completely surveyed during a workday.

The protocols for surveying and for determining social, nesting, and reproductive status can be found in Verner et al. (1990). In general, we attempted to apply equal survey effort over years and study areas. Survey effectiveness may have been influenced by inclement weather conditions, such as high winds or steady rain, and by water noise when surveying drainages. If budgets decline, then a priority system of calling will be initiated in

an effort to obtain full coverage (six surveys) at least in sites where owl pairs were detected in previous years. Mixed conifer sites will have the highest priority, low-elevation sites will receive only three surveys unless an owl is detected. Sites above 8,000 ft (2,438 m) that have had no history of territorial owls may not be surveyed.

Survival rates (adults, subadults, and juveniles) and fecundity were used to estimate the population growth rate [lambda (λ)]. Adult and subadult survival rate (S) included both males and females and included owls that may temporarily occupy a territory. Jolly-Seber (J-S) survival estimates were calculated with the J-S capture-recapture model for open populations, allowing for losses and gains to the population between sampling periods. A sampling period was defined as one field season (1 March-30 September). Assumptions of the J-S model were that (1) all individuals in the population have equal survival and capture probabilities, and (2) emigration was permanent. The juvenile survival rate (S_o) was estimated at 0.328, the current estimate for a closed population of spotted owls in southern California (LaHaye et al. 1997). Fecundity (b) equaled the number of female fledglings produced divided by the number of females checked for reproduction. Assuming a 50/50 sex ratio of juveniles, fecundity was calculated by halving the mean number of young fledged per pair. The estimate of λ allowed testing of the hypothesis that a population was significantly increasing ($\lambda>1$) or decreasing ($\lambda<1$). The appropriate test statistics followed a *Z*-distribution.

RESULTS

SURVEY

Surveys began in all study areas in the first week of March and ended on 30 September. The changes in survey effort that occurred in 1997 were continued in 1999. Variations in survey success are influenced by weather, crew size, and/or funding and may result in partial coverage in some sites that usually receive full coverage.

DETECTION AND CAPTURE

In the SNF we detected 56 adult and subadult owls, an increase of 6 over 1998 (table 1a). Twenty-four pairs were detected in 1999 and 16 juveniles were produced. For the ten years of the study, the SNF has averaged 27.9 pairs and 15.6 juveniles per year. The adult-subadult ratio was 79:21; an additional 6 subadults (3 males and 3 females) were found on the study area as compared to the 1998 results (table 2a). In 1999, eight owls (1 male subadult and 7 females—2 adult, 5 subadult) were captured. Four of the five juveniles produced in 1998 were captured or observed (using radio telemetry) in the spring of 1999 within the study area, indicating at least an 80% survival rate for juveniles during the winter of 1998-1999. All four of the juveniles from the 1998 cohort were observed in the oak woodland habitat in early spring, a straight-line distance of approximately 15 miles to the wintering area from the natal area. Two of the 1998 cohorts were identified as females and were found paired with territorial males; both were captured and color banded. One banded cohort found paired in the oak woodlands was relocated in the conifer habitat paired with a different male. By May, the two radio-transmittered cohorts had moved back to the conifer habitat and subsequently beyond the northern boundary of the SNF study area.

In SNP, 58 owls were detected in 1999, the same number as in 1998. Twenty-eight pairs were detected in 1999 and 28 juveniles fledged (table 1b). For the ten years of the study, the SNP has averaged 27.6 pairs and 15.6 juveniles per year. The adult-subadult ratio was 93:7 on the SNP in 1999. Four owls were captured and banded (1 adult female, 1 subadult female, and 2 adult males, one of which was a returning 1992 cohort). All juveniles but one were captured and banded, and five were fitted with radio transmitters.

In the NS study area, 23 owls were detected: 10 pairs, one single male, and one male and female present but not confirmed as a pair (table 1c). Only one juvenile fledged in this

study area during the 1999 season. NS averaged 12.3 pairs and 3.7 juveniles per year over the 6 years of study. Three new owls—1 adult male, 1 subadult male, and 1 adult female—were captured and banded. The adult/subadult ratio was 95:5, the same as in 1998. In 5 of the 6 years of study, the NS has had a greater than 90% ratio of adults (table 2c), but reproduction is less than in either SNF or SNP. We captured and banded all juveniles detected in 1999.

DENSITIES

Crude densities of owls in 1999 were 0.349/mi^2 on SNF, 0.446/mi^2 on SNP, and 0.223/mi^2 on NS (table 3). For the SNF this was an increase over the 1998 level while the SNP remained the same as 1998 and NS continued to decline (fig. 1). Mean crude densities over all years of study were 0.431/mi^2 on SNF, 0.493/mi^2 on SNP, and 0.277/mi^2 on NS. Crude densities

RETURN RATES, MOVEMENTS, VACANCIES, AND REPLACMENTS

Because each color-banded owl has a unique combination of colors, we can identify individual owls from year to year. This permits us to determine when a given individual returns to its territory of the previous year, moves to another territory within the study area, or vacates its territory of the prior year and is not relocated within the study area. It also permits us to determine when a vacancy is filled by another individual owl—either banded and moved from elsewhere in the study area or unbanded and of unknown origin. Such a replacement constitutes a "turnover event," the rate of which is very significant in the demography of an animal species.

In SNF, 44 banded owls had confirmed status in 1998-1999: 36 owls (82%) returned to the study area in 1999, 8 were confirmed missing, 6 were replaced (turnovers), and 3 moved to new territories (table 4). The mean, annual return rate for all banded owls from 1990 through 1999 was 80%. Return rates for subgroups (males, females; adult males, adult females; and adults) all averaged about 80% but subadults, with a return rate of only 76%, faired worse (subadult males at 68%, subadult females at 88%).

In NS, 18 banded owls had confirmed status in 1998-1999: 15 returned in 1999, 3 were missing, and one was replaced (table 5). The mean, annual return rate for all banded owls from 1994 through 1999 was 80%. The mean for adult males was 78% and for adult females was 87%. Only five subadults have been banded so far in this study area, too few to estimate turnover rates at this time.

In SNP, 49 banded owls had confirmed status in 1998-1999: 46 were relocated in 1999, 3 were missing, 2 were replaced, and none moved within the SNP study area (table 6). The empirical return rate in 1999 was 94%. The mean, annual return rate over the period 1990-1999 was 86.5%. Return rates for subgroups (males, females; adult males, adult females; adults and subadults) all averaged about 85-87%.

NESTING ATTEMPTS AND REPRODUCTION

The proportion of territorial pairs in our study areas in the southern Sierra Nevada that attempted to nest was higher in 1999 than in 1998. *In SNF*: 16 of 21 (76%) pairs checked to established "nesting" protocols attempted to nest, but only 8 of 22 pairs (36%) checked to "reproduction" protocols fledged young—a total of 16, or a mean of 0.73 across the 22 pairs (table 7a). Each of the reproductive pairs produced two young (table 8a). *In SNP:* 12 of 20 pairs nested (60%) and 16 of 27 (59%) pairs produced a total of 27 young, for a mean 1.0 young per pair checked to protocol for reproduction (table 7b). The number of young fledged per pair ranged from one to three and averaged 1.69 (table 8b). *In NS:* 2 of 10 pairs nested, and 1 of 10 pairs reproduced, fledging only 1 young for a mean of 0.10 young per pair checked to protocol for reproduction (table 7c).

Over the 10 years of the study, we have records of 334 young that have been

fledged—156 in SNF, 156 in SNP, and 22 in NS (only 6 years of study). Three hundred (90%) of these have been banded with cohort bands (all receiving the same color combination for a given year). If one of these birds returns to one of the study areas in a subsequent year, we endeavor to recapture it and replace its cohort band with a unique color combination. We can identify it to an individual nest and year because each fledged young also receives a numbered aluminum band issued by the Bird Banding Laboratory in Laurel, Maryland. Of 256 fledglings banded prior to 1999, 44 (17%) have been recaptured within the study area boundaries, at least 9 others have been resighted but not recaptured, for an observed return rate of 21%.

The sex ratio of 33 of the young produced this year, as determined from blood samples by a genetics laboratory in Davis, California, was 13:30 (male:female). From a sample of 165 young over the period from 1993 to 1999, the fledgling sex ratio was 85:80 (male:female)—not significantly different from 1:1.

Reproduction has varied markedly from year to year of the study but has differed little between study areas during any given year. In both the SNF and SNP, the proportion of pairs fledging young was >40% in 4 years (1990, 1992, 1993, and 1994) and <40% in 5 years (1991, 1995, 1996, 1997, and 1998). In 1999, however, the proportion of pairs fledging young in SNF was only 36%, but the proportion in SNP was 59%.

POPULATION TRENDS AND DEMOGRAPHIC VALUES

Preliminary estimates of the rates of population change [lambda (λ)] were 0.906 for SNF, 0.908 for SNF and NS combined, 0.971 for SNP—values for SNF and SNF and NS combined are significantly less than 1.0 ($P = 0.00001$), but that for SNP is not ($P = 0.078$) (table 11). Mean fecundity (b) increased for SNF and SNP but dropped slightly for NS. Reproduction in SNF and SNP was higher this year than each of the previous 6 years, but reproduction in NS was the second lowest of the 6 years. Mean fecundity for 1990-1999 was 0.316 in SNF, 0.277 in SNF and NS combined, and 0.300 for 1988-1999 in SNP. Estimated combined adult and subadult survival rates were 0.814 in SNF, 0.825 in SNF and NS combined, and 0.882 in SNP.

DISCUSSION

Observed numbers of territorial owls increased in 1999 in SNF for the first time since 1994, and numbers in SNP did not decline for the first time since 1995. The SNF count was 33% lower than the peak year of 1994, and the SNP count remained 28% below the peak count in 1995. These results may be partly explained by an increase in survival rates, as estimated by return rates. In addition, the survival rate of Sierra Forest juveniles from 1998 was exceptionally high (at least 80%), possibly providing a floater base to begin filling vacant territories. Mild winter weather in 1998-1999 may be a factor contributing to the higher survival rates of all age classes, and it probably also played a role in the higher than average reproductive rates in SNF and SNP. The SNP in particular had a markedly higher than average reproductive year in 1999 (fecundity was 81% higher than the 1988-1998 average fecundity). A late season storm may have caused some nest failures in the SNF; however this storm did not appear to have a negative effect on nesting success in the SNP. The storm's effect on the owls may not have been evenly distributed across study areas, nor within study areas, as most nests below 5,000 ft in SNF produced young, but all but one nest above that elevation failed. Weather records for June 2nd and 3rd indicated that the northern end of SNF received 1.5 inches of precipitation, the southern end of SNF and northern end of SNP received 1 inch, and the southern end of SNP received 0.10 inches, with snow being recorded above the 5,000-foot level.

Our calculation of the rate of population change (lambda λ) from 1988-1999 suggests that the owl population is declining at an annual rate of approximately 10% in SNF and 3% in

SNP. In our 1998 annual report, a calculation error gave an estimated λ-value of 0.940 for SNP. The corrected value is 0.956, still significantly less than 1.0 ($P < 0.05$) and only slightly less than the average over 1988-1997. The 1988-1999 λ value of 0.971 for SNP is not significantly less than 1.0, although it approaches significance ($P = 0.078$). The 1988-1999 λ values for SNF and NS both continue to indicate highly significant declining trends. The difference between the SNF and SNP is largely attributable to the higher adult survival rate (return rate) observed in SNP, as λ is most sensitive to this value (Noon et al. 1992). Over the life of the study, adult survival rates were almost 7% higher in SNP than in SNF.

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TABLE 1a. Summary of social status of adult and subadult California spotted owls on the SNF.

SOCIAL STATUS	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Pair	31	27	32	33	34	27	26	25	20	24
Single male	0	2	1	4	4	3	1	3	2	1
Single female	0	0	1	1	0	1	1	0	0	0
Male & female present	5	0	1	1	1	2	2	0	1	1
Male present	9	10	1	4	8	5	4	3	4	3
Female present	4	3	3	2	0	3	5	0	2	2
Unknown present				1	2	0	1	1	0	0
Total Number of Owls	85	69	72	80	84	70	68	57	50	56
Juveniles	22	6	52	23	20	1	4	8	2	16
Juveniles detected after July 15		1	1							
Total Juveniles	22	7	53	23	20	1	4	8	2	16

TABLE 1b. Summary of social status of adult and subadult California spotted owls on the SNP.

SOCIAL STATUS	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Pair	22	23	27	28	34	33	28	29	24	28
Single male	0	0	0	0	0	0	0	0	0	0
Single female	0	1	0	0	0	1	2	1	0	0
Male & female present	2	5	0	2	0	2	0	0	0	0
Male present	5	1	5	4	4	6	5	1	6	2
Female present	1	0	0	2	2	2	0	3	4	0
Unknown present	0	2	1	1	0	1	3	0	0	0
Female replaced					1					
Total Number of Owls	54	60	60	67	75	80	66	63	58	58
Juveniles	12	1	43	15	22	3	3	11	9	27
Juveniles detected after July 15	9									1
Total Juveniles	21	1	43	15	22	3	3	11	9	28

TABLE 1c. Summary of social status of adult and subadult California spotted owls on the NS.

SOCIAL STATUS	1994	1995	1996	1997	1998	1999
Pair	15	14	13	12	10	10
Single male	0	0	0	0	0	1
Single female	1	1	1	1	2	0
Male & female present	0	0	0	0	1	1
Male present	3	1	1	0	0	0
Female present	2	1	0	1	0	0
Unknown present	1	2	0	0	0	0
Total Number of Owls	37	33	28	26	24	23
Juveniles	9	1	2	4	3	1
Juveniles detected after July 15	2					
Total Juveniles	11	1	2	4	3	1

Table 2a. Sex and age class distribution of California spotted owls identified to age class on the SNF.

		1994		1995		1996		1997		1998		1999	
Sex	Age Class	N	%	N	%	N	%	N	%	N	%	N	%
Male	Adult	22	60	22	79	25	86	25	93	23	96	23	85
	Subadult	15	40	6	21	4	14	2	7	1	4	4	15
	Combined	37		28		29		27		24		27	
Female	Adult	28	85	26	90	22	73	21	84	17	81	18	72
	Subadult	5	15	3	10	8	27	4	16	4	19	7	28
	Combined	33		29		30		25		21		25	
Both	Adult	50	71	48	84	47	80	46	89	40	89	41	79
	Subadult	20	29	9	16	12	20	6	11	5	11	11	21
	Combined	70		57		59		52		45		52	

Table 2b. Sex and age class distribution of California spotted owls identified to age class on the SNP.

		1994		1995		1996		1997		1998		1999	
Sex	Age Class	N	%	N	%	N	%	N	%	N	%	N	%
Male	Adult	22	65	28	82	27	93	26	100	25	96	26	96
	Subadult	12	35	6	18	2	7	0	0.0	1	4	1	4
	Combined	34		34		29		26		26		27	
Female	Adult	28	88	33	97	29	97	31	100	24	92	25	89
	Subadult	4	12	2	3	1	3	0	0.0	2	8	3	11
	Combined	32		35		30		31		26		28	
Both	Adult	50	76	61	87	57	93	57	100	49	94	51	93
	Subadult	16	24	9	13	4	7	0	0.0	3	6	4	7
	Combined	66		70		61		57		52		55	

Table 2c. Sex and age class distribution of California spotted owls identified to age class on the NS.

		1994		1995		1996		1997		1998		1999	
Sex	Age Class	N	%	N	%	N	%	N	%	N	%	N	%
Male	Adult	11	85	12	86	12	92	12	100	9	90	10	91
	Subadult	2	15	2	14	1	8	0	0.0	1	10	1	9
	Combined	13		14		13		12		10		11	
Female	Adult	9	75	15	94	11	100	12	92	11	100	11	100
	Subadult	3	25	1	6	0	0	1	8	0	0	0	0
	Combined	12		16		11		13		11		11	
Both	Adult	20	80	27	90	23	96	24	96	20	95	21	95
	Subadult	5	20	3	10	1	4	1	4	1	5	1	5
	Combined	25		30		24		25		21		22	

Data prior to 1994 can be found in the 1998 annual report.

TABLE 3.

CRUDE DENSITY

Mean crude density estimates (owls per mi^2) for California Spotted Owls on the SNF, SNP, and NS . Crude density was calculated by dividing the number of owls detected by the number of square miles in each study area.

SNF (160.4 mi^2)	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Owls Detected	85	69	72	80	84	70	68	57	50	56
Crude Density mi^2	0.530	0.430	0.449	0.499	0.524	0.436	0.424	0.355	0.312	0.349

SNP (130.0 mi^2)	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Owls Detected	54	60	60	67	75	80	66	63	58	58
Crude Density mi^2	0.415	0.462	0.462	0.515	0.577	0.615	0.508	0.485	0.446	0.446

NS (103.0 mi^2)	1994	1995	1996	1997	1998	1999
Owls Detected	37	33	28	26	24	23
Crude Density mi^2	0.359	0.320	0.272	0.252	0.233	0.223

TABLE 4. Return, missing, replacement and movement rates for only banded California spotted owls on the SNF: (1998-1999).

Sex	Age Class	No Banded 1998	RETURNED N	RETURNED %	MISSING N	MISSING %	REPLACED N	REPLACED %	MOVED N	MOVED %
Male	Adult	22	18	82	4	18	3	14	2	9
	Subadult	1	1	100	0	-	0	-	0	-
	Unknown	0	0	-	0	-	0	-	0	-
	Total	23	19	83	4	17	3	13	2	9
Female	Adult	16	13	81	3	19	2	13	1	6
	Subadult	4	4	100	0	-	0	-	0	-
	Unknown	1	0	0	1	100	1	100	0	-
	Total	21	17	81	4	19	3	14	1	5
Both	Adult	38	31	82	7	18	5	13	3	8
	Subadult	5	5	100	0	-	0	-	0	-
	Unknown	1	0	-	1	100	1	100	0	-
	Combined	44	36	82	8	18	6	14	3	7

TABLE 5. Return, missing, replacement and movement rates for only banded California spotted owls on the NS: (1998-1999).

Sex	Age Class	No Banded 1998	RETURNED N	RETURNED %	MISSING N	MISSING %	REPLACED N	REPLACED %	MOVED N	MOVED %
Male	Adult	7	7	100	0	-	0	-	0	-
	Subadult	1	0	0	1	100	1	100	0	-
	Unknown	0	0	-	0	-	0	-	0	-
	Total	8	7	88	1	12	1	12	0	-
Female	Adult	10	8	80	2	20	0	0	0	-
	Subadult	0	0	-	0	-	0	-	0	-
	Unknown	0	0	-	0	-	0	-	0	-
	Total	10	8	80	2	20	0	-	0	-
Both	Adult	17	15	88	2	12	0	-	0	-
	Subadult	1	0	-	1	100	1	100	0	-
	Unknown	0	0	-	0	-	0	-	0	-
	Combined	18	15	83	3	17	1	6	0	-

TABLE 6. Return, missing, replacement and movement rates for only banded California spotted owls on the SNP: 1998-1999.

Sex	Age Class	No Banded 1998	RETURNED N	RETURNED %	MISSING N	MISSING %	REPLACED N	REPLACED %	MOVED N	MOVED %
Male	Adult	23	22	96	1	4	0	-	0	-
	Subadult	0	0	-	0	-	0	-	0	-
	Unknown	0	0	-	0	-	0	-	0	-
	Total	23	22	96	1	4	0	-	0	-
Female	Adult	24	22	92	2	8	2	8	0	-
	Subadult	2	2	100	0	-	0	-	0	-
	Unknown	0	0	0	0	-	0	-	0	-
	Total	26	24	92	2	8	2	8	0	-
Both	Adult	47	44	94	3	6	2	4	0	-
	Subadult	2	2	100	0	-	0	-	0	-
	Unknown	0	0	0	0	-	0	-	0	-
	Combined	49	46	94	3	6	2	4	0	-

Data prior to 1999 can be found in the 1998 annual report.

TABLE 7a. Mean number of young fledged per pair of California spotted owls checked for reproduction by 15 July on the SNF.

YEAR	Pairs Checked N	Young Found N	Young Per Pair Mean
1990	18	22	1.22
1991	13	6	0.46
1992	30	52	1.73
1993	33	23	0.70
1994	33	20	0.61
1995	26	1	0.04
1996	25	4	0.16
1997	25	8	0.32
1998	19	2	0.10
1999	22	16	0.73

Table 7b. Mean number of young fledged per pair of California spotted owls checked for reproduction by 15 July on the SNP.

YEAR	Pairs Checked N	Young Found N	Young Per Pair Mean
1990	8	12	1.50
1991	12	1	0.08
1992	27	43	1.59
1993	25	15	0.60
1994	29	22	0.76
1995	33	3	0.09
1996	27	3	0.11
1997	27	11	0.41
1998	22	9	0.41
1999	27	27	1.00

TABLE 7c. Mean number of young fledged per pair of California spotted owls checked for reproduction by 15 July on the NS.

YEAR	Pairs Checked N	Young Found N	Young Per Pair Mean
1994	11	9	0.82
1995	14	1	0.07
1996	12	2	0.17
1997	10	4	0.40
1998	10	3	0.30
1999	10	1	0.10

TABLE 8a. Mean number of young fledged per pair of California spotted owls that fledged young on the SNF.

YEAR	Pairs Checked N	Young Found N	Young Per Pair Mean
1990	13	22	1.69
1991	5	6	1.20
1992	26	52	2.00
1993	14	23	1.64
1994	14	20	1.43
1995	1	1	1.00
1996	3	4	1.33
1997	6	8	1.33
1998	2	2	1.00
1999	8	16	2.00

TABLE 8b. Mean number of young fledged per pair of California spotted owls that fledged young on the SNP.

YEAR	Pairs Checked N	Young Found N	Young Per Pair Mean
1990	7	12	1.71
1991	1	1	1.00
1992	23	43	1.87
1993	11	15	1.36
1994	14	22	1.57
1995	2	3	1.50
1996	2	3	1.50
1997	6	11	1.83
1998	6	9	1.50
1999	16	27	1.69

TABLE 8c. Mean number of young fledged per pair of California spotted owls that fledged young on the NS.

YEAR	Pairs Checked N	Young Found N	Young Per Pair Mean
1994	5	9	1.80
1995	1	1	1.00
1996	1	2	2.00
1997	2	4	2.00
1998	2	3	1.50
1999	1	1	1.00

Table 11. Estimation of demographic parameters and rate of population change for the Sierra National Forest Study Areas, combined Sierra Study Areas, and the Sequoia and Kings Canyon National Parks Study Area

SNF		Sierra Forest		SNP	
1987-1995		1987-1995		1988-1995	
S_o =	0.349 (Est.)	S_o =	0.349 (Est.)	S_o =	0.349 (Est.)
S =	0.8295	S =	0.8338	S =	0.8631
b =	0.405	b =	0.3702	b =	0.3365
Lambda	**0.95258**	**Lambda**	**0.94744**	Lambda	0.96783
z =	**1.77871**	**z =**	**2.05052**	z =	1.19524
P =	**0.038**	**P =**	**0.02**	P =	0.11
1987-1996		1987-1996		1988-1996	
S_o =	0.349 (Est.)	S_o =	0.349 (Est.)	S_o =	0.349 (Est.)
S =	0.8174	S =	0.8257	S =	0.8575
b =	0.3616	b =	0.3226	b =	0.2940
Lambda	**0.92850**	**Lambda**	**0.92608**	**Lambda**	**0.95011**
z =	**2.91207**	**z =**	**3.24961**	**z =**	**2.10198**
P =	**0.0018**	**P =**	**0.0006**	**P. =**	**0.018**
1987-1997		1987-1997		1988-1997	
S_o =	0.328 (Est.)	S_o =	0.328 (Est.)	S_o =	0.328 (Est.)
S =	0.8318	S =	0.8356	S =	0.8692
b =	0.3350	b =	0.3004	b =	0.2827
Lambda	**0.930**	**Lambda**	**0.9246**	**Lambda**	**0.9537**
z =	**3.099**	**z =**	**3.632**	**z =**	**2.237**
P =	**0.001**	**P =**	**0.0001**	**P =**	**0.013**
1987-1998		1987-1998		1988-1998	
S_o =	0.328 (Est.)	S_o =	0.328 (Est.)	S_o =	0.328 (Est.)
S =	0.8057	S =	0.8177	S =	0.8736
b =	0.3108	b =	0.2784	b =	0.2766
Lambda	**0.897**	**Lambda**	**.901**	**Lambda**	**0.956**
z =4.505		**z =4.863**		**z =2.086**	
P < 0.00001		**P < 0.00001**		**P = 0.0180**	
1987-1999		1987-1999		1988-1999	
S_o =	0.328 (Est.)	S_o =	0.328 (Est.)	S_o =	0.328 (Est.)
S =	0.8135	S =	0.8250	S =	0.8822
b =	0.3156	b =	0.2771	b =	0.2996
Lambda	**0.906**	**Lambda**	**0.908**	Lambda	0.971
z = 4.2765		**z = 4.768**		z = 1.418	
P < 0.00001		**P < 0.00001**		P = 0.0781	

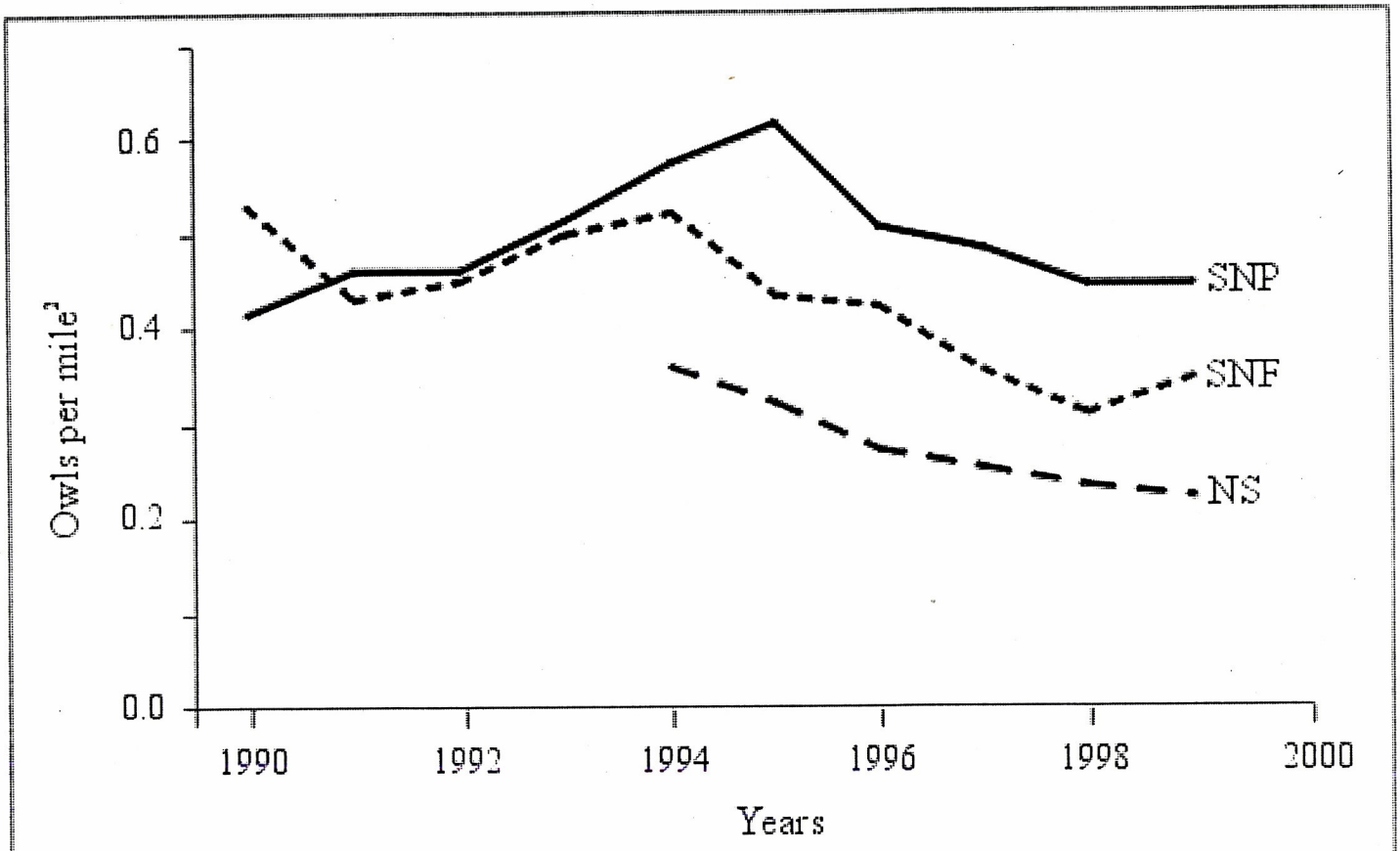

Figure 1. Estimated crude density of territorial California Spotted Owls on the Sierra study area (SNF), Sequoia and Kings Canyon National Parks study area (SNP), and the new Sierra study area (NS). Crude density includes all habitat types within the study boundaries regardless of suitability as owl habitat.